

NASAL SUPPORT DEVICE FOR DOMESTIC MAMMALS AND METHOD

Cross-Reference to Related Application

The present application is a continuation-in-part of copending U.S. Ser. No. 08/843,741 filed April 21, 1997, the entire disclosure of which is incorporated by
5 reference herein.

Field of the Invention

The present invention is directed to facilitating air flow through the nasal passages of a domestic animal. Specifically, the invention provides a device and method for supporting the soft tissue structures of the nasal passages of a domestic animal.

Background of the Invention

Portions of the following discussion of the nasal anatomy of domestic mammals are excerpted from R. Nickel et al., *The Viscera of Domestic Animals*, (2nd revised ed.), Springer-Verlag, New York, Hiedelberg, Berlin (1979), pp. 211-221. This is an excellent
15 text on the comparative visceral anatomy of domestic mammals. As used herein, the terms "mammal" and "animal" are used synonymously and refer to non-human mammals.

The nasal anatomy of domestic animals is considerably different than that of a human. Unlike the human nose that projects distinctly from the face, in domestic
20 animals, the nose is incorporated into the face and forms the large dorsal and lateral areas rostral to the eyes. The nostrils in the apex of the nose are the entry to the respiratory system of domestic mammals. Once passing through the nostrils, inspired air moves into the nasal cavities and continues through the nasopharynx, larynx, trachea and lungs.

At the apical entrance to the nose the nostrils are partitioned by the nasal septum to divide the nasal cavity into right and left halves. The caudal portion of the septum is bony, while rostrally the septum consists of cartilage which becomes progressively more flexible toward the apex.

5 The wall of the nose consists of skin externally and a middle supporting layer of bone caudally and cartilage rostrally. The nasal cavity is lined by a mucous membrane. The rostral bones forming the wall of the nose include the nasal, maxillary and incisive bones. The free borders of the nasal and incisive bone provide attachment for the cartilages which support the nostrils. The supporting bones and cartilages of the nose are
10 associated with the nasal muscles that regulate the size of the nostrils.

The dorsal and ventral lateral nasal cartilages are formed by the widening of the rostral part of the nasal septum along its dorsal and ventral margins. In the horse, the ventral lateral nasal cartilage is small and may be absent. In many domestic animals, there is no lateral support for the soft tissue over the rostral nasal passage caudal to the
15 nostril.

A further difference in the formation of the nasal cartilages of the horse is the presence of alar cartilages. The alar cartilages consist of a ventral cornu and a dorsal lamina and support the nostrils dorsally, medially and ventrally. The lamina of the alar cartilage and the medial accessory cartilage support the nasal diverticulum, a blind pouch
20 in the dorsal aspect of the nostril.

The muscles of the nose and upper lip act to dilate the nostrils. This is particularly noticeable during labored breathing. In the horse, these muscles are well developed and can transform the normally semilunar nostrils to become circular.

exertion of domestic mammals. Specifically, there is a need to increase, or reduce the decrease of, nasal passage narrowing that can occur during breathing in domestic mammals, especially performance animals such as the horse, camel, and dog.

5

Summary of the Invention

The present invention provides a device and method for using the device to support the unsupported nasal tissues of a domestic animal. The invention addresses providing support in view of the structural and physiological characteristics unique to the nose of a non-human animal, for example, a horse. In some embodiments, a nasal support device (NSD) disclosed herein can reduce inspiratory air flow impedance by at least about 5-10%

In one embodiment the invention is a NSD for securing to the nose of a domestic animal. The NSD provides support to the right and left lateral vestibular walls of a domestic animal. The device includes a support layer and a right and left side piece which when secured to the nose of the animal are positioned to provide structural support to the right and left lateral vestibular walls. The side pieces of the device can meet at the midline region of the device. When secured to the nose of a domestic animal, the midline region of and NSD of the invention straddles the left and right nasal bones of the animal. The sides and the midline region each have a rostral end, a caudal end and a rostral-poll dimension. In one embodiment, the rostral -poll dimension of the midline region is at least as great as either of the rostral-poll dimensions of the side pieces. In an alternative embodiment, the rostral- poll dimension of the midline region is greater than either of the rostral-poll dimensions of the side pieces. In some embodiments, the rostral end of the

NSD can extend rostrally between the nostrils in the form of a "tongue" to provide externalizing support to the soft tissues between the nostrils.

An NSD configured according the invention can be used on many different animals. In one embodiment an NSD is sized to fit a member of the Equidae family, including the domestic horse. The device is suitable for adults and young animals. In general, the structural aspects of an NSD of the invention can be configured and sized to fit the nose of, for example, a dog, human, horse, camel, etc.

In general, an NSD comprises a support layer, an engaging layer, and in some embodiments a surface layer and/or pad layer. The support layer of an NSD can include one or more lift members to support the vestibular wall. The lift members can traverse the nose and extend to a point dorsal to the ventral border of the vestibular wall, or beyond the ventral border of the vestibular wall lateral to the incisive bone.

Alternatively, one or more lift members of an NSD can be applied over each vestibular wall and stent each vestibular wall independently without connecting to one another across the midline of the nose.

The invention further provides a method for supporting a first and second vestibular free wall of a domestic animal by securing a device which supports the first and second vestibular free walls to the nose of the animal. In one embodiment, the method includes use of an NSD as disclosed herein.

The method of the invention provides for facilitating air flow through the nasal passages of a domestic animal. The device and method of the invention are particularly advantageous for use in the horse and are beneficial for facilitating athletic performance

or for reducing the occurrence, severity or affect(s) of respiratory diseases in an adult or young animal.

A device and method according to the invention can be used on an animal that is running freely in a pasture, or wearing saddlery, harnesses or other equipment that can be
5 attached to the nose of the animal.

Brief Description of the Drawings

FIG. 1a is a top view of one configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 1b is a top view of a second configuration of an embodiment of an NSD
10 which incorporates the functional aspects of the invention.

FIG. 1c is a top view of a third configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 1d is a top view of a fourth configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 1e is a top view of a fifth configuration of an embodiment of an NSD which
15 incorporates the functional aspects of the invention.

FIG. 1f is a top view of a sixth configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 1g is a top view of a seventh configuration of an embodiment of an NSD
20 which incorporates the functional aspects of the invention.

FIG. 1h is a top view of an eighth configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 1i is a top view of a ninth configuration of an embodiment of an NSD which incorporates the functional aspects of the invention.

FIG. 2 is a perspective view of the bony and cartilaginous anatomy of the rostrum nasal cavity of the horse.

5 FIG. 3 is a profile view of the bony anatomy of the rostral nasal cavity of the horse.

FIG. 4 is a dorsal or top view of the bony anatomy of the rostral nasal cavity of the horse.

FIG. 5 is a top plan view of one embodiment of an NSD with the surface layer removed and the support layer exposed.
10

FIG. 6 is a top plan view of a second embodiment of an NSD with the surface layer removed and the support layer exposed.

FIG. 7 is a top plan view of a third embodiment of an NSD with the surface layer removed and the support layer exposed.

15 FIG. 8 is a frontal view of a horse having an embodiment of an NSD of FIGs. 5 or 6 secured to its nose.

FIG. 9 is a front view of a horse having an embodiment of an NSD of FIG. 7 secured to its nose.

FIG. 10 is an exploded perspective view of the components of the embodiment of
20 an NSD configured as shown in FIG. 5.

FIG. 11 is a bottom plan view of an engaging layer of an embodiment of an NSD having a discontinuous adhesive pattern.

FIG. 12 is a bottom plan view of an embodiment of an NSD having holes throughout the thickness of the device.

FIG. 13 is an exploded perspective view of the NSD shown in FIG. 12.

Detailed Description of the Invention

The invention is directed to devices and methods for supporting the soft tissue at the rostral aspect of the nasal cavity of domestic mammals. Specifically, the devices and methods disclosed herein provide support for the unsupported region of the “vestibule” in the rostral nasal cavity.

As used herein, domestic mammals include most non-human production and performance animals having a nose incorporated into the face, rather than projecting therefrom, that can benefit from a device according to the invention. Such mammals include dogs, sheep, goats, cattle, horses, camels, llamas, etc. A device according to the invention can be particularly useful for members of the Equidae family including horses, donkeys, mules, zebras etc.

As used herein, “performance activities” or “work” includes activities such as pulling, driving, racing (flat, steeple, barrel, etc.), eventing, hunting, jumping, rodeoing, trail riding, endurance riding, etc. In general, the device can be used anytime it is desired to facilitate or enhance nasal air intake. In addition, to facilitating air flow, an NSD according to the invention can also be used to treat or prevent respiratory ailments in adult or young animals such as foals and calves. It is foreseen that the devices and methods of the invention may be particularly beneficial in horses for reducing the severity or affect(s) of laryngeal hemiplegia, chronic obstructive pulmonary disease

(COPD) or exercise related pathologies such as myositis, dorsal displacement of the soft palate (DDSP), or exercise induced pulmonary hemorrhage (EIPH) or "bleeding".

As used herein, the term "rostral" refers to that aspect of the nose or anatomical structure closest to the apex of the nose. "Caudal" refers to that aspect of the nose closest to the poll or caudal aspect of the head relative to the apex. The "vestibule" refers to the rostral aspect of the nasal cavity that is defined by the alar cartilages rostrally, the incisive bone ventrally, the nasal bone dorsally, the caudal intersection of the incisive and nasal bones caudally, and the nasal septum medially. Thus, supported regions of the vestibule are supported by bone or cartilage.

The "unsupported" region of the vestibule is also referred to as the "lateral (free) wall" of the vestibule or "vestibular wall". The lateral wall of the vestibule includes the unsupported soft tissue defined by the nostrils rostrally, the lateral free border of the nasal bone dorsally, the dorsal free border of the incisive bone ventrally, and the intersection of the nasal and incisive bone caudally. In the horse, the dorsal border of the unsupported region can include the dorsal lateral nasal cartilage and, in some species, the ventral border can include the ventral lateral nasal cartilage. Herein, "soft tissue" has its general meaning including skin, muscle, fat, connective tissue or associated integumentary structures.

In general, the anatomy of soft muzzled mammals such as the horse and camel give rise to unique physical mechanical problems in supporting the vestibular soft tissues. For example, in the horse, the alar cartilages that are attached at the rostral border of the nasal septum supports the alar fold which gives rise to the blind cutaneous pouch referred to as the "false" nostril. Providing structural support for the vestibule of the horse

preferably includes providing support of the alar fold. A suitable support device according to the invention, preferably causes minimal irritation to the skin or other anatomic structures of the animal when in use or after removal.

Other anatomical and physiological characteristics of a soft muzzle animal must be overcome to provide a suitable NSD for these animals. For example, the hair that covers the external vestibular tissues can reduce the ability of an NSD to remain adhered to the animal's nose under certain conditions. In addition, the presence of numerous sweat glands in this region, with or without the presence of hair, can also significantly reduce the ability of an NSD to remain adhered to this region when the animal is perspiring.

A further unique characteristic is the significant mobility of the external soft tissues in the vestibular region of some animals. For example, the muscular anatomy associated with the vestibular wall and nostrils of the horse enables considerable flexion, extension, twisting and side-to-side motion of the external vestibular tissues. The repeated in and out movement of the vestibular tissues during inspiration and expiration also affects the ability of an NSD to maintain a functional position in these animals. Thus, the combination of hair, sweat and vestibular wall movement during intense exercise present unique challenges to adherence and functioning of an NSD in certain animals, such as the horse.

Another factor considered in providing an NSD for support of the vestibule of a horse or camel is the equipment, including saddlery or harnesses, worn by the animal when working. Generally, "saddlery" refers to bits, bridles, martingales, muzzles, headcollars, saddles and other equipment used with a riding animal. "Harness" refers to

equipment used with a driving animal. A suitable configuration and arrangement of an NSD of the invention preferably does not interfere with the functioning of saddlery or harnesses and the saddlery or harnesses preferably do not interfere with the functioning of the NSD.

5 It should be noted that an NSD according to the present invention need only engage the lateral free wall of the vestibule, it does not need to engage the nostrils. Upon visual inspection it will be appreciated that the nostril of the horse can expand to a cross-sectional area that is greater than an unsupported cross-sectional area measured in the nasal cavity in the region of the lateral vestibular wall. However, it is foreseen that
10 support of the nostril could be provided in some circumstances. In the horse, for example, the muscles of the nose and upper lip generally provide significant flaring of the nostril during labored breathing.

Some exemplary embodiments of a device of the invention and its components are described below. Throughout the specification guidance is provided by examples of
15 representative groups, the groups are not meant to be limiting.

The configuration and arrangement of an NSD of the invention is determined by the configuration of the tissue to be supported, the amount of support needed and the unique physiological or anatomical characteristics of the animal. Generally, the unique nasal anatomy of domestic animals necessitates configurations, arrangements or
20 dimensions which are different than that required for a human nose. In addition, as discussed previously, hair, sweat and vestibular wall mobility affect the structural arrangement necessary for functionality of an NSD.

In a typical embodiment, a herein disclosed NSD provides support to the right and left lateral vestibular walls of the animal. Generally, the device includes a support layer having a right and left side piece which when secured to the nose of the animal are positioned to provide structural support to the right and left lateral vestibular walls. The "right" and "left" side pieces can also be referred to as "first" and "second" or "second" and "first" side pieces. The NSD is generally bilaterally symmetrical and does not utilize a narrow intermediate section between the side pieces. The side pieces of the device meet at about the midline a midline region of the device. When the NSD is secured to the nose of a domestic animal, the intersection of the right and left side pieces at the midline region substantially straddles the left and right nasal bones of the animal.

The side pieces and the midline region of an NSD each have a rostral end, a caudal end and a rostral-poll dimension. Because of the size and related anatomy of the surface area of the vestibular free wall of, for example a horse, to provide sufficient support to benefit the animal, the rostral-poll dimension at the midline region of an NSD of the invention can be substantially equal to or greater than the rostral poll dimension of the side pieces that engage the vestibular free wall. Hence, in one embodiment, the rostral-poll dimension of the midline region is at least as great as the rostral-poll dimension of either of the side pieces. In an alternative embodiment, the rostral- poll dimension of the midline region is greater than the rostral-poll dimension of the right or left side piece. However, a device having a relatively narrow intermediate region similar to some devices available for humans, and modified to include an increased surface area, modified support system and modified adhesive system may provide some benefit to an animal.

In addition, it is foreseen, that although the preferred configuration of an NSD of the invention is particularly advantageous for use on animals such as horses, the unique configurations disclosed herein can provide an advantageous improvement in dilators for a human nose. Moreover, a device having the general configuration of a preferred
5 embodiment of the invention, but sized for use with a human nose, can also advantageously provide a sun blocking, or visor effect, for the proximal and /or rostral end of a human nose. Two configurational embodiments particularly suited for a human or animal nose are illustrated in FIG. 1h and 1i. In one preferred embodiment for humans, at least two lift members of 1400A Gauge MYLAR®, available from DuPont
10 Films, Wilmington DE, are applied transversely as support members in an NSD configuration such as that illustrated in FIG. 1h.

In some embodiments, the rostral end of the NSD at or near the midline region extends to the apex of the muzzle between the nostrils and is referred to as a "tongue". This embodiment can provide lift support to the most rostral aspect of the soft tissues and
15 cartilaginous nasal septum between the nostrils.

The structural configuration and arrangement of an NSD can vary in some aspect(s) and still maintain the mechanical functioning of a device according to the invention. Personalization of the external design of an NSD can reflect aesthetics, personal tastes, racing colors, etc. The overall appearance of the embodiments illustrated
20 in the present disclosure are not exhaustive of those which are within the scope of the invention. Examples of a few general configurations which impart some or all of the functional aspects of the invention are shown in the top plan views of FIG. 1a-i, and 5-

13. Generally the bottom plan configuration of an NSD is substantially identical to the top plan configuration shown. The side plan view is substantially void of ornamental features.

As used herein, the term "support" refers to reducing the amount of narrowing of the nasal passage that can occur during inspiration or expiration of domestic animals. Accordingly, "support" can include some drawing in of the vestibular free wall at the rostral nasal passage during inspiration, but less than that which would occur without a device of the invention. "Support" also includes maintaining the position of the external soft tissue over the rostral nasal passage in a neutral position. As used herein, "neutral" refers to a state where the unsupported vestibular tissues are neither drawn into the nasal cavity nor protruding externally relative to a resting position. In some arrangements, "support" also includes maintaining the vestibular free wall in a "distended" outward position relative to the neutral position.

The configuration and arrangement of a support device for animals takes into account the anatomical and physiological characteristics of the vestibular free wall as well as the bony structures defining its borders. Moreover, in most large domestic animals, the structural support necessary to support the lateral free wall must also take into account the weight of the tissue supported and the proper leveraging for distributing the weight supported without causing pressure sores or other irritation to surrounding tissues. In addition, due to the muscle control of the upper lip of the horse, supporting the vestibular free wall must also address the active and passive mobility of the muzzle structures.

The size of a device of the invention can vary. Appropriate sized devices will typically correspond with muzzle size which can vary with the body size, breed, age, and sex, of the animal. It is foreseen that smaller size NSDs for young animals, such as calves and foals can be beneficial in treating, for example, upper respiratory ailments. In some embodiments, the rostral-poll midline dimension of an NSD for an average sized adult horse is about 3 to 16 cm, preferably 6-14 cm and the rostral poll dimension of the right and left side is about 3 to 12 cm. However, larger and smaller sizes may be used.

The transverse dimension of an NSD can also vary. The “transverse dimension” is defined as the length of the device from the peripheral edge of one side of the device to the peripheral edge of the second side of the device. The transverse dimension can be approximately equal at the rostral and caudal edge. Alternatively, the transverse dimension can vary in a single device depending if measured, for example, along the caudal edge, the rostral edge, the narrowest part or the widest part. In one embodiment of an NSD for an average size horse, the transverse dimension at the narrowest part can be about 5-12 cm and about 10-17cm at the widest part.

Typically, an NSD according to the invention includes at least a “support layer” and an “engaging layer”. In some embodiments a “surface layer” can be present to cover the side of the support layer that is away from the nose of the animal when the device is secured to the nose of the animal. Some embodiments can also include one or more “pad layers” which can help reduce the chance of pressure sores caused by the device.

The support layer provides the majority of the support for the vestibular free wall of the nasal passage of an NSD. Generally, support is provided in the support layer through the use of one or more “lift members.” As used herein a “lift member” can be

prepared from any suitable material which provides the desired support to the vestibular free wall. Examples of suitable materials for a lift member include thermoplastic resins, thermoset resins, shape memory metals, alloys, leather, etc. The lift member can be a unitary open mesh or solid material. Alternatively, the lift member can be two or more individual sections of an open mesh or solid material. A preferred thermoplastic resin for a lift member is a polyester such as MYLAR® available from DuPont Films, Wilmington DE.

In some embodiments, the lift members are of a generally uniform thickness throughout their length and width. The thickness of the lift members will typically be selected based on the support needed, and is generally the same throughout. However, the lift member can also vary in thickness in different regions of the device. In addition, a lift member need not be the same width throughout its length. That is, the lift member can be wider at the lateral ends of the lift member. Alternatively, a lift member can be wider in the region that will lie over the midline region of the nose and narrower on the ends.

Suitable thickness for a lift member prepared from a polyester such as MYLAR® for an adult large animal such as a horse is about .008 to about .020 inches. In one preferred embodiment, the thickness of a support member for an average size adult horse is about .014 inches.

The support layer can include one or more lift members. In one embodiment using a single lift member, the configuration of the peripheral edge of the lift member can define the external contours of the overall device. In other embodiments, two and

preferably, three or more lift members are used. In such embodiments, a plurality of lift members can be arranged parallel along the transverse dimension of the device.

Alternatively, a plurality of lift members can be oriented perpendicular to one another such that one or more lift members are oriented parallel to the transverse dimension of the device and one or more lift members are oriented parallel to the rostral-poll dimension of the device. In yet another embodiment, two or more lift members can be oriented in a substantially criss-cross arrangement to form an "X" shaped appearance in top plan view.

In some embodiments it is advantageous to provide lift members in a rostral caudal direction. Lift members oriented in a rostral caudal direction can be located in the side pieces to further provide the lift of the NSD. In addition, or alternatively, lift members can be oriented in a rostral caudal direction at or near the midline intersection of the first and second side pieces. This arrangement of the lift members is particularly advantageous for NSD embodiments which extend rostrally to form a "tongue" for support of the soft tissue between the nostrils.

When using multiple solid lift members, the spacing between individual lift members can affect the adherence and overall functioning of an NSD. Appropriate spacing between individual lift members provides for the device to adaptively conform to the changing contours of the vestibular wall of an animal during inspiration, expiration or other movements, without disengaging from the animal's nose.

The width, length and spacing of one or more lift members can vary based on the overall dimensions of the particular NSD. Also, the length of the individual lift members can vary in a single device so as to traverse some or all of the dorsal-ventral dimension of the vestibular free wall. Preferably, the transverse length dimension of a lift member is

sufficient to traverse the midline of the animal's nose and extend to the right and left side pieces beyond the dorsal lateral nasal cartilages to support the right and left vestibular free walls. In some embodiments, the lift members can extend beyond the ventral edge of the vestibular free wall to a point lateral to the incisive bone. Generally, the lift members provide a "lift" effect on the vestibular free wall to reduce drawing of the vestibular free wall into the nasal passage during respiration. However, if the lift members extend beyond the ventral edge of the vestibular free wall to the lateral aspect of the incisive bone, the incisive bone can act with the lift members to "stent" the vestibular free wall and facilitate the reduction of the drawing of the vestibular wall into the nasal cavity that is provided by the lift members. This may be particularly advantageous in large animals during labored breathing.

When two or more lift members are used, the width of the lift members and the spacing between lift members are selected for the NSD to provide the desired support to the vestibular wall with sufficient flexibility to reduce the chance of irritation due to localized pressure at leveraging points on the animal's nose. In addition, use of multiple lift members provides for torsional flexibility of the device which helps maintain the functioning of the device when subjected to the unique mobility of an animal's vestibular tissues. In one embodiment of an NSD for an average size adult horse, the length of the lift members can be about 4-18 cm, preferably about 9-12 cm, the width can be about 0.2 to 2 cm and the spacing between lift members about 0.2 to 2 cm, preferably about 0.3 to 0.7 cm.

In one embodiment, the lift member can be a single member of a previously described solid or open mesh material that is shaped to stent a single vestibular wall.

That is, the outer contours of the lift member are configured to follow the peripheral margins of the vestibular wall. Preferably, the perimeter edge of the lift member is extended to allow the lift member to overlap the borders of the vestibular wall by about 0.2 - 2 cm. According to this embodiment, the lift member can include an engaging layer and optionally a surface or pad layer as described below. Preferably, the engaging layer can extend beyond the perimeter of the lift member to enhance adherence to an animal's nose. However, rather than connecting at the midline region of the nose, this embodiment of an NSD comprises two separate pieces, that act as a stent for each vestibular wall.

An NSD preferably includes an engaging layer. The engaging layer provides for securing an NSD to the animal. If no surface layer (described below) is present and individual lift members are used, the engaging layer can also provide for maintaining the unity of the device. Typically, the engaging layer can secure the NSD to the nose by use of an adhesive. Other invasive forms of engaging to the nose, such as suturing, are possible but not desired. Preferably, the adhesive is biocompatible and provides minimal or no contact irritation when applied to the external tissues of an animal.

Suitable materials for the adhesive of the engaging layer are single or double coated medical tape, transfer adhesives, or liquid adhesives. A release liner is preferably applied to the NSD to protect the adhesive surface of the engaging layer until application to an animal. Pressure sensitive adhesives (PSA) can be used. Examples of suitable adhesive systems are No. 1509 double sided medical tape and No. 9942 Hydrocolloid Skin Protective Adhesive available from 3M Co., St. Paul, MN. A preferred adhesive system is No. 1524 transfer adhesive available from 3M Co., St. Paul, MN.

The adhesive can be continuous over the surface of the engaging layer.

Alternatively, the adhesive can be in a discontinuous pattern that can be formed in multiple ways. For example, a discontinuous pattern can be applied as a pre-cut double sided medical tape or transfer adhesive. Alternatively, the adhesive can be applied as a liquid adhesive in a discontinuous pattern using methods such as gravure coating. A variety of patterns may be used including circles, ovals stripes or polygons, such as rectangles, squares, triangles etc. The hexagonal pattern depicted in FIG. 11 is conveniently applied, but not required. The pattern need not be symmetrical. In addition, the discontinuous adhesive pattern may extend to the periphery of the device or a continuous pattern adhesive border can be applied around the perimeter of the engaging layer. In addition, two or more adhesives may be used in combination to optimize adherence under different conditions. For example a first adhesive could provide greater adherence under dry conditions and a second adhesive provide greater adherence under moist conditions.

In an alternative embodiment, the adhesive can be applied in a continuous pattern and subsequently made discontinuous. For example, holes can be formed through the entire thickness of an NSD after a continuous adhesive is applied to the engaging layer, thus forming a discontinuous adhesive layer. No particular pattern of holes is necessary. However, preferably, the pattern of the holes is relatively evenly distributed over the entire surface area of the device and the locations of the holes are selected to avoid penetration through the lift members. As discussed above, the shape of the holes forming the discontinuous pattern can be round, oval, polygons etc. The ratio of adhesive

area:non-adhesive area of a discontinuous adhesive pattern can be about 90:10 to 10:90, typically about 30:70 to 70:30, and in some embodiments, about 40:60-60:40.

Without being limited to a single theory, it is believed that in addition to permitting passage of perspiration to the exterior surface of the device, the discontinuous
5 adhesive pattern, particularly in the form of holes facilitates malleability of the device to permit the device to more readily conform to the surface contours of the vestibular free wall without loss of adherence or reduced support of the device.

The NSD can include a surface layer. The surface layer is the layer farthest from the soft tissues of the animal. The side of the surface layer closest to the soft tissue of the
10 animal can include an adhesive to adhere the surface layer to the support layer, to the top side of the engaging layer that may be exposed between lift members, or to the pad layer if used. The surface layer can provide additional support to the vestibular wall and help maintain unity of the components of an NSD. A suitable surface material can be breathable or non-breathable and typically includes a biocompatible adhesive. An
15 example of a breathable material suitable as a surface layer is No. 1533 available from 3M Inc., St. Paul, MN. One preferred non-breathable surface material is No. 9906T non-woven medical tape available from 3M Co., St. Paul, MN. This material has been found to advantageously flex with the surface contour changes of the vestibular wall thus reducing the likelihood that the device will disengage from the animals nose, for
20 example, during strenuous exercise. Preferably, because this material is non-breathable, holes are created through the entire thickness of the device to provide for passage of moisture and further cooperative malleability of the NSD.

The support layer can mount directly to the engaging layer. However, the NSD can also include a "pad layer" applied between the engaging layer and support layer. Alternatively, the pad layer can be applied between the surface layer and the support layer. An adhesive may be applied to both sides of the pad layer, only a single side or not all. That is the pad layer can be "free floating."

In another embodiment, a partial pad layer can be applied. According to this embodiment, the pad layer can be applied between the support layer and the surface layer. The pad layer can be adhered to the layers on either side of the pad layer or only to the layer on one side. For example, the pad layer can be applied between the support layer and engaging layer, but only adhered to the engaging layer and regions of the surface layer between individual lift members.

The pad layer can be formed of any suitable known material. One preferred material is a polyester material that allows the skin of the vestibular wall beneath the device to breathe. An example of a suitable pad layer is the product SONTARA® (style nos. 8004, 8005, 8027 etc.) available from E.I. DuPont Nemours & Co., DuPont Nonwoven Division, Old Hickory, TN. SONTARA® is a nonwoven, spunlaced, breathable polyester fabric.

If no pad layer is used, the support layer can mount directly to the engaging layer using a double sided adhesive. Alternatively, the lift members can be adhered to a non-adhesive side of the engaging layer, or to a nonadhesive pad layer using a double sided adhesive such as 3M 1509, 3M Inc., St. Paul, MN. Other arrangements are foreseen. For example, the adhesive of the engaging layer can be applied between the support layer and

surface layer. According to this embodiment, the engaging layer adheres to the animal's nose between individual lift members that are not adhered to the animal.

The surface layer can include an ornamental design color, pattern, logo etc. if desired. Alternatively, an ornamental veneer layer can be applied to the exposed surface of a surface layer or support layer.

The engaging layer, surface layer, or pad layer (if used) can closely follow the external contours defined by the support layer. Alternatively, the periphery of the engaging or other layers can extend beyond the contours defined by the support layer. In a preferred embodiment, extending the periphery of the engaging layer beyond the contours defined by the support layer can provide improved engagement of the NSD to the animal's nose. In one embodiment a margin region of about 0.5 cm to 5 cm, preferably about 2-3 cm of engaging layer extends beyond the support provided by the support layer. If present, the surface layer typically has the same perimeter dimensions as the engaging layer.

Generally, the overall thickness of the device is uniform. Some variation in thickness can occur due to differences in thickness of those regions of the device including the support members and those regions having spacing between support members.

The inventors also recognize that single or multiple lift members without a unifying layer (eg. surface layer or engaging layer) can be used. According to this embodiment, an engaging layer, such as a previously described adhesive, can be applied to the lift member. One or more lift members can then be applied directly to the animal's nose. While this embodiment may address the unique physiological and anatomical

aspects of an animals nose as disclosed herein, the application and removal of the support members will be cumbersome. In addition, the support provided by the surface layer or engaging layer in the regions between the lift members will be lost.

Detailed Description of Illustrated Embodiment

Anatomical reference points and embodiments of an NSD according to the invention will be described in detail with reference to the drawings using the horse as an example. Like reference numerals represent like parts and assemblies throughout the several views. Reference to the drawings is not intended to limit the scope of the invention.

FIG. 1a-i are each a top view of a configuration of an embodiment of an NSD which incorporates the functional aspects of an NSD as disclosed herein. The embodiments shown are exemplary and are not intended to limit the scope of configurations that incorporate the principles of the invention. FIG. 1c shows various dimensions which can be used to characterize an NSD according to the invention wherein letters followed by a subscript "T" are the transverse dimensions including C_T is the caudal edge transverse dimension, R_T is the rostral edge transverse dimension, N_T is the narrowest part transverse dimension and W_T is the widest part transverse dimension. S is the rostral-poll dimension of the side piece and M is the rostrum poll dimension of the middling region.

Bony anatomical structures which surround the vestibule free wall in the horse that is supported by a device of the invention is described with reference to FIGS 2-4. FIG 2 is a perspective view of the bony and cartilaginous structures of the rostrum nasal

cavity of the horse. FIG. 3 is a profile view of the bony anatomy and FIG. 4 is a top view of the same rostrum anatomy of FIG. 3. Figs. 3 and 4 do not show cartilaginous anatomy of the adult horse.

The lateral free wall of the vestibule is defined dorsal by the dorsal lateral nasal cartilage **1** which is the lateral most aspect of the nasal bone **2**. The ventral border of the vestibule free wall is defined by the dorsal free wall **3** of the incisive bone **4**. The caudal aspect of the vestibule free wall is defined by the intersection **5** of the nasal **2** and incisive **4** bones. The rostrum aspect of the vestibule free wall is bordered by the nostril (not shown) which is supported dorsal by the lamina **6** and ventral by the corn **7** of the allure cartilage **8**. The medial accessory cartilage **9** and the lamina **6** of the allure cartilage support the “false” nostril of the horse. The cartilaginous rostrum nasal septum **10** is shown in FIG. 2.

FIGs. 5-7 illustrate three different embodiments of an NSD (**15**, **16**, **17**) according to the invention. The surface layer is removed in each of these figures to expose the top side of the support layer **20** and the top side of the pad layer **21** which covers the engaging layer (not-shown). The support layer **20** includes transverse lift members **22** in FIGs. 5-7 and longitudinal lift members **23** in FIG. 7. The lift members **22** of FIG. 5 are narrower but greater in number than the lift members **22** of FIG. 6. In the embodiment of FIG 2. the transverse dimension of the lift members range from 9 cm to 14 cm, the width of the transverse members is about 0.6 cm, the spacing between members is about 0.6 cm and the thickness of the lift members is about 0.14 inches. In the embodiments of FIGs. 5-7, the peripheral contours of the pad layer (and engaging layer) extend beyond the lift members.

As shown in FIGs. 5-7, an NSD includes a first side piece **24** and a second side piece **25** that intersect at the midline **26** of the midline region **26a** of the device. In use, the rostral end **27** of the device is oriented towards the apex of the nose and the caudal end **28** is oriented towards the eyes of the animal. In FIG. 5, the midline rostral-poll dimension **M** at the midline **26** is at least equal to the side piece rostral-poll dimension **S** of side pieces **24** and **25**. Also as shown in the embodiments of FIGs. 5-7, preferably, the rostral-poll dimension of the NSD at the midline **M** is greater than the rostral-poll dimensions **S** of the first or second side pieces **24**, **25**. In FIG. 7, the NSD includes a rostrally extending center piece or “tongue” **29** that can extend rostrally to engage the nose between the nostrils.

In use, an NSD is secured to the animal’s nose oriented generally as shown in FIGs. 8 and 9. FIG. 8 is a front view of a horse **30** having an embodiment of an NSD **31** having an external configuration as shown in FIGs. 5 and 6 (**15** and **16**, respectively) secured to the nose **32**. FIG. 9 is a front view of a horse **30** having an embodiment of an NSD **17** as shown in FIG. 7 secured to its nose **32**. As can be seen in FIG. 9, the tongue **29** of the NSD **17** extends between the nostrils **33** of the horse **30**.

FIG. 10 is an exploded perspective view of the components making up an embodiment of an NSD **15** as shown in FIG. 5. According to this embodiment, the engaging layer **40** includes an adhesive surface **41** to secure the NSD **15** to an animal’s nose. A pad layer **42** is adhered to the engaging layer **40**. The pad layer **42** can have an adhesive layer or be adhesive free. In the embodiment shown, the engaging layer **40** is a double sided adhesive such that the top side **43** of the engaging layer will adhere to the pad layer **42**. The support layer **44** includes lift members **45**. The lift members **45** can be

adhered to the pad layer 42 using, for example, a double sided adhesive 46. A surface layer 47 can be applied over the support layer 44 to provide unity, additional strength or a “canvas” for applying an ornamental design to the device. Suitable materials for each of the layers have been described previously. The releasable liner for protecting the adhesive surface 41 of the engaging layer is not shown.

FIG. 11 illustrates the engaging layer 110 of another embodiment of an NSD 100 with the releasable liner removed. According to this embodiment, a discontinuous adhesive pattern 101 is applied to the NSD 100 as a pre-cut medical tape or transfer adhesive or applied as a printed liquid adhesive. As described earlier, a polygon adhesive pattern 104 is one of several suitable discontinuous adhesive patterns. While the illustrated embodiment does not include holes, the areas void of adhesive 102 in the adhesive pattern 101 provide for perspiration to pass through a breathable or non-breathable surface layer to the surface of the NSD. It is believed that areas void of adhesive 102 of the adhesive pattern 101 of the engaging layer 110 facilitates engagement of the NSD 110 to the mobile contours of the vestibular wall of some animal’s noses, such as a horse. However, it is also foreseen that a pattern similar to that shown in FIG. 11 can include two different adhesives. That is, a first adhesive could be applied as the adhesive pattern 104 and second adhesive applied in regions 102. The two different adhesives could provide adhesive function under different conditions. For example, the first adhesive may provide greater adherence to the nose when the nose is dry and the second adhesive could provide greater adherence when the nose is wet from perspiration.

In addition, rather than extending the adhesive pattern to the peripheral edge 109 of the NSD, the engaging layer 110 can include a continuous adhesive border around the

perimeter of the NSD. Such a border can be about 0.5 to 5 cm, typically about 2-3 cm wide.

FIG. 12 illustrates a bottom plan view of another embodiment of an NSD 150 having a discontinuous adhesive pattern 101 of the engaging layer 110. The releasable liner has been removed. In this embodiment, the discontinuous adhesive pattern 101 is provided by creating holes 107 through the entire thickness of the device. Note that the holes 107 preferably do not pass through the lift members 105. In addition to enhancing the ability of the device 150 to adapt to contour changes of the external surface of the vestibular wall, it is believed that holes 107 provide for passage of perspiration or other moisture from the surface of the animals nose to the external surface of the device 150. The ability for moisture to pass external to the device further reduces the chance of the device 150 disengaging from the nose. As discussed earlier, the shape of the holes is not limited to round.

FIG. 13 is an exploded perspective view of the NSD 150 of FIG. 12. This embodiment includes a surface layer 103 having an adhesive 120 on the underside 121 of the surface layer 103 for adhering the surface layer 103 to the top side 123 of the lift members 105. One suitable material for the lift members 105 is 1400A MYLAR® (ie 1400 gauge MYLAR® which is about 350 micron or 14 mils) available from DuPont, Wilmington, DE. A presently preferred surface material 103 is No. 9906T non-woven medical tape available from 3M Co., St. Paul, MN. The engaging layer 110 can be applied as a liquid adhesive to the underside 121, 124 of the surface layer 103 and lift members 105, respectively. Alternatively the engaging layer can be applied to the

underside 121, 124 of the surface layer 103 and lift members 105, respectively, as a double sided medical tape or transfer adhesive. In one embodiment, two layers of No. 1524 transfer adhesive, available from 3M Co., St. Paul, MN., provide the adhesive for the engaging layer 110.

5 An NSD as disclosed herein provides support for the nasal passages of an animal.

The support provides for increased airflow at rest and during exercise. The air flow facilitating affects of an NSD can be determined by various methods including measurement of air flow rates, driving pressure for flow and impedance to air flow. Air flow rates can be measured by attaching a pneumotachograph to a face mask worn by an exercising horse. Driving pressure for flow can be measured by passing a catheter via the nares to the pharynx. From the pressure and flows, impedance to air flow can be calculated. Flow volume loops may demonstrate reduction of dynamic collapse of the nasal passages. It is believed that some embodiments of an NSD as described herein will provide at least about 5-10% reduction in inspiratory impedance, in some embodiments at least about 15-25%, and in some embodiments over a 25% reduction. During preliminary studies, one horse showed over 40% reduction in inspiratory impedance when wearing an NSD of the invention. A detailed description of methods useful for measuring air flow affects of an NSD are described in Lumsden et al., "Use of Flow-Volume Loops to Evaluate Upper Airway Obstruction in Exercising Standardbreds," AJVR, 54(5):766-775 (May 19, 1993).

In a performance horse, an NSD can be particularly beneficial for reducing the chance of exercise induced respiratory conditions. For example, the inventors foresee use of an NSD to reduce the chance of exercise induced pulmonary hemorrhage (EIPH) or

